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Ota et al.

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(54) **BATTERY ADAPTER**

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439/639

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See application file for complete search history.

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(56) **References Cited**

U.S. PATENT DOCUMENTS

5,028,858 A 7/1991 Schnizler et al.
5,418,403 A * 5/1995 Morell, III 307/72

(Continued)

FOREIGN PATENT DOCUMENTS

JP 2008-178278 A 7/2008
JP 2011-161602 A 8/2011
WO WO 2011/099349 8/2011

OTHER PUBLICATIONS

Dec. 2, 2014 Office Action issued in Japanese Application No. 2011-252650.

(Continued)

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H01R 31/00 (2006.01)
H01R 31/06 (2006.01)
H01M 2/10 (2006.01)
H01M 10/42 (2006.01)
B25F 5/02 (2006.01)

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(58) **Field of Classification Search**

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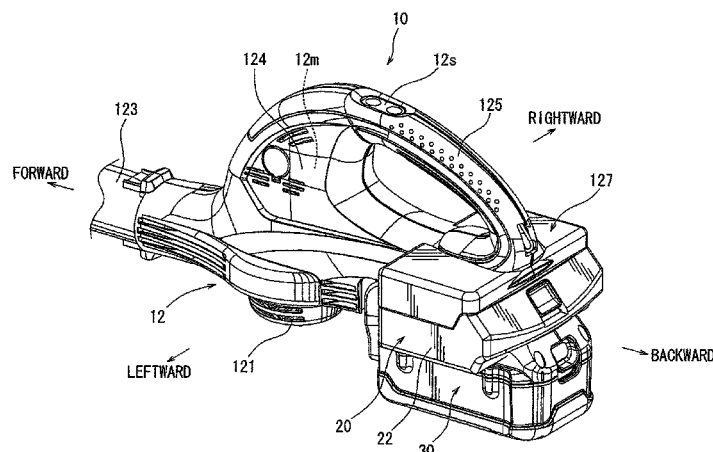
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(57) **ABSTRACT**

A battery adapter can include a plurality of machine-side-connecting sections capable of being connected to a plurality of battery-connecting ports provided on an electric machine, and a battery-side-connecting section(s) to which a battery or batteries can be connected. The number of the machine-side-connecting sections is preferably configured to be larger than the number of the battery-side-connecting section(s). Further, the electric machine is preferably connected to the machine-side-connecting sections of the battery adapter through its battery-connecting ports. The electric machine can be driven by the battery or batteries connected to the battery-side-connecting section(s) of the battery adapter.

19 Claims, 14 Drawing Sheets



(56)

References Cited

U.S. PATENT DOCUMENTS

6,007,373	A *	12/1999	Chew	439/504
6,087,815	A *	7/2000	Pfeifer et al.	323/282
6,166,519	A *	12/2000	Gault	320/107
6,806,683	B2 *	10/2004	Saldana et al.	320/110
7,576,516	B2 *	8/2009	Greenslade	320/110
2004/0108837	A1 *	6/2004	Lai et al.	320/137
2005/0280393	A1	12/2005	Feldmann	

2007/0210744	A1 *	9/2007	Watson et al.	320/112
2009/0108806	A1	4/2009	Takano et al.	
2012/0139500	A1 *	6/2012	Ye et al.	320/135
2013/0025893	A1 *	1/2013	Ota et al.	173/2

OTHER PUBLICATIONS

Extended Search Report issued in European Patent Application No. 12193032.5 dated May 8, 2014.

* cited by examiner

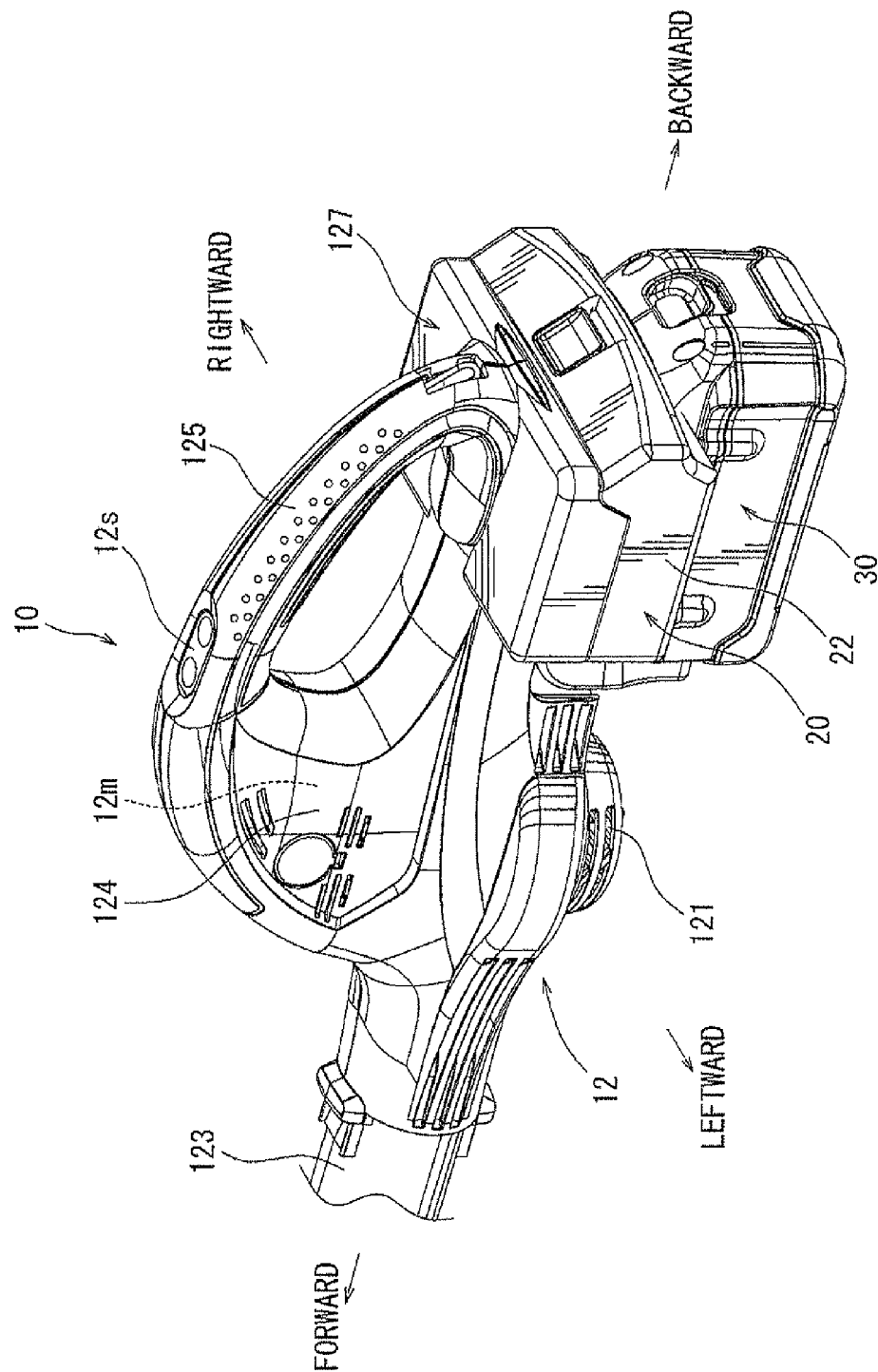


FIG. 1

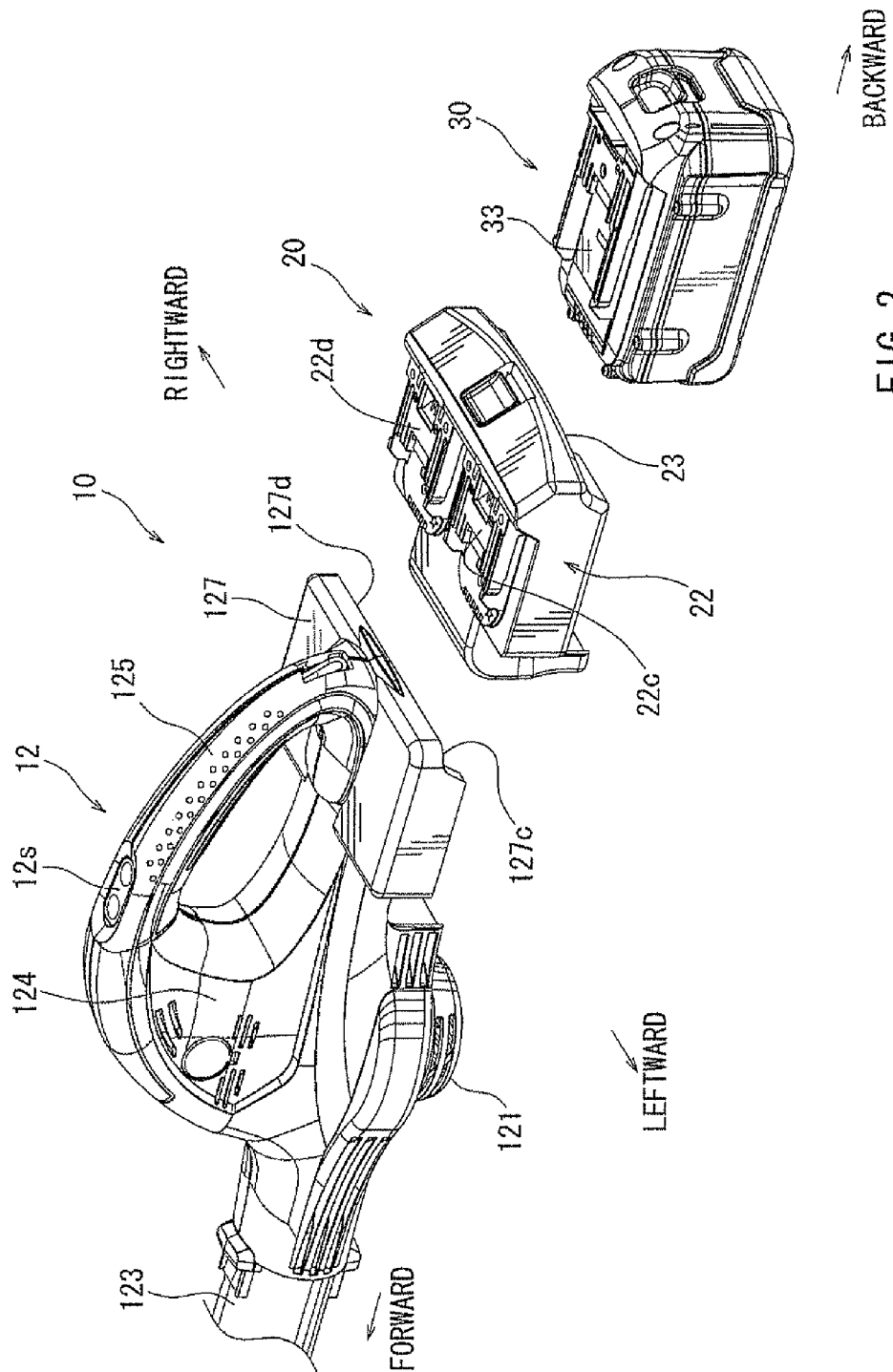
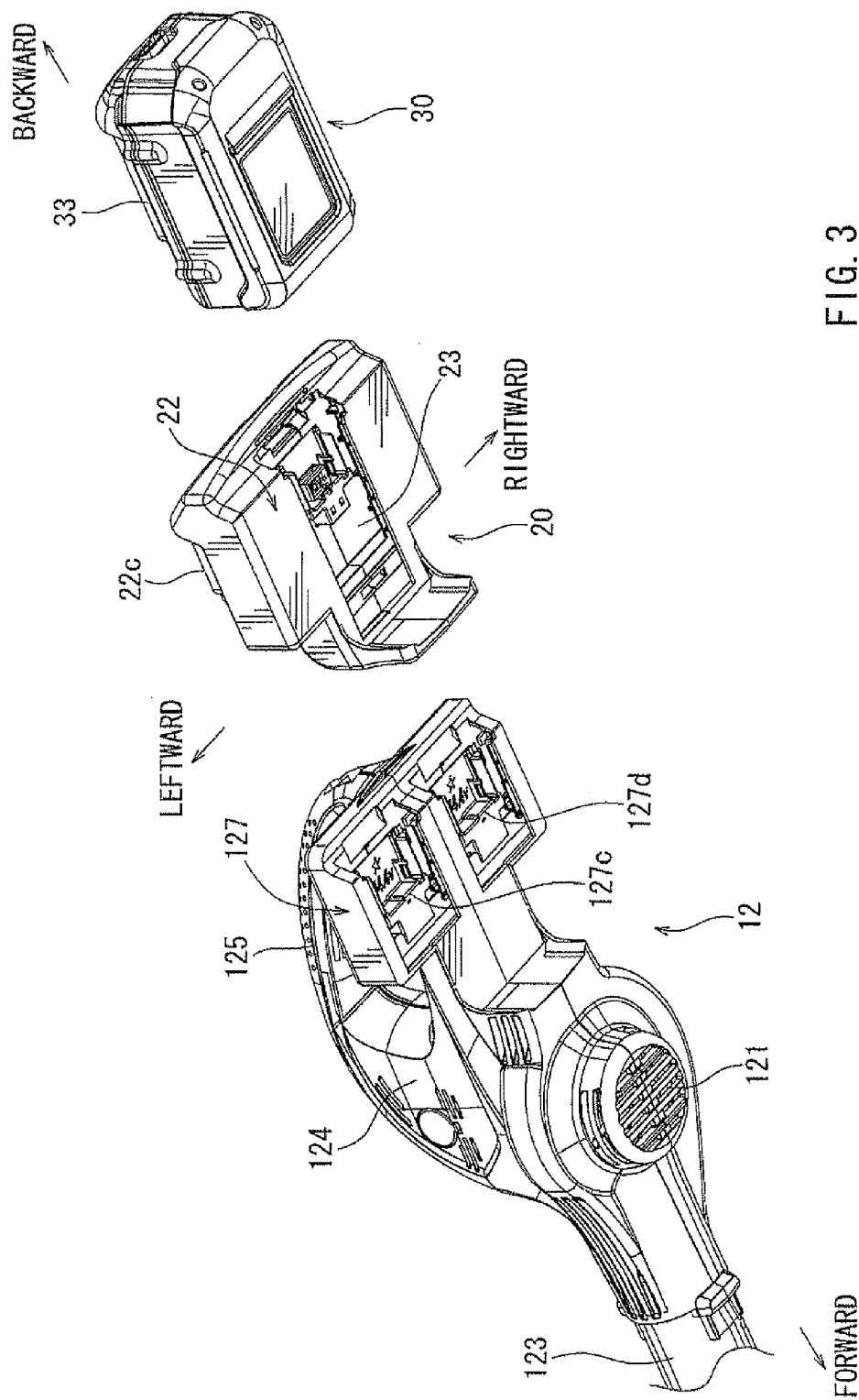


FIG. 2



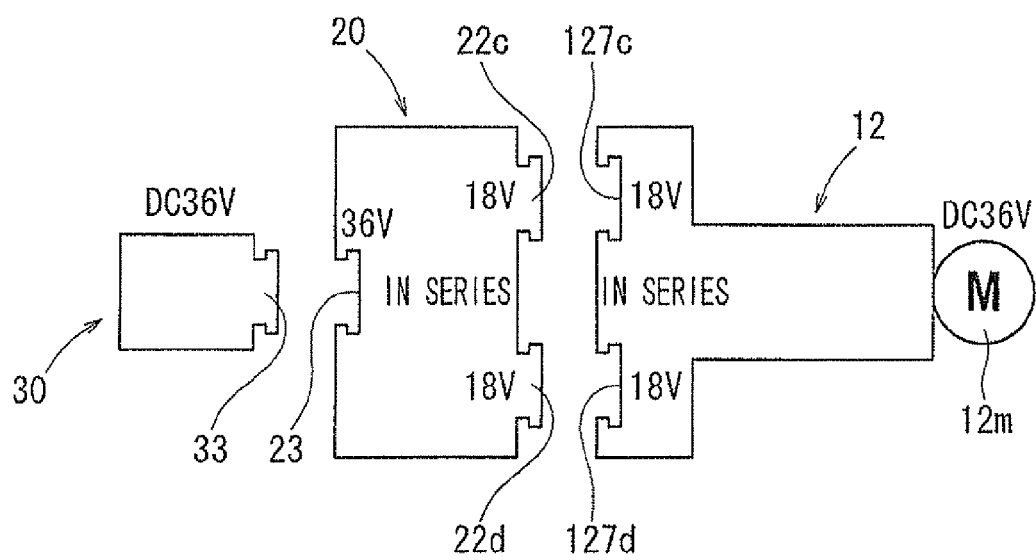
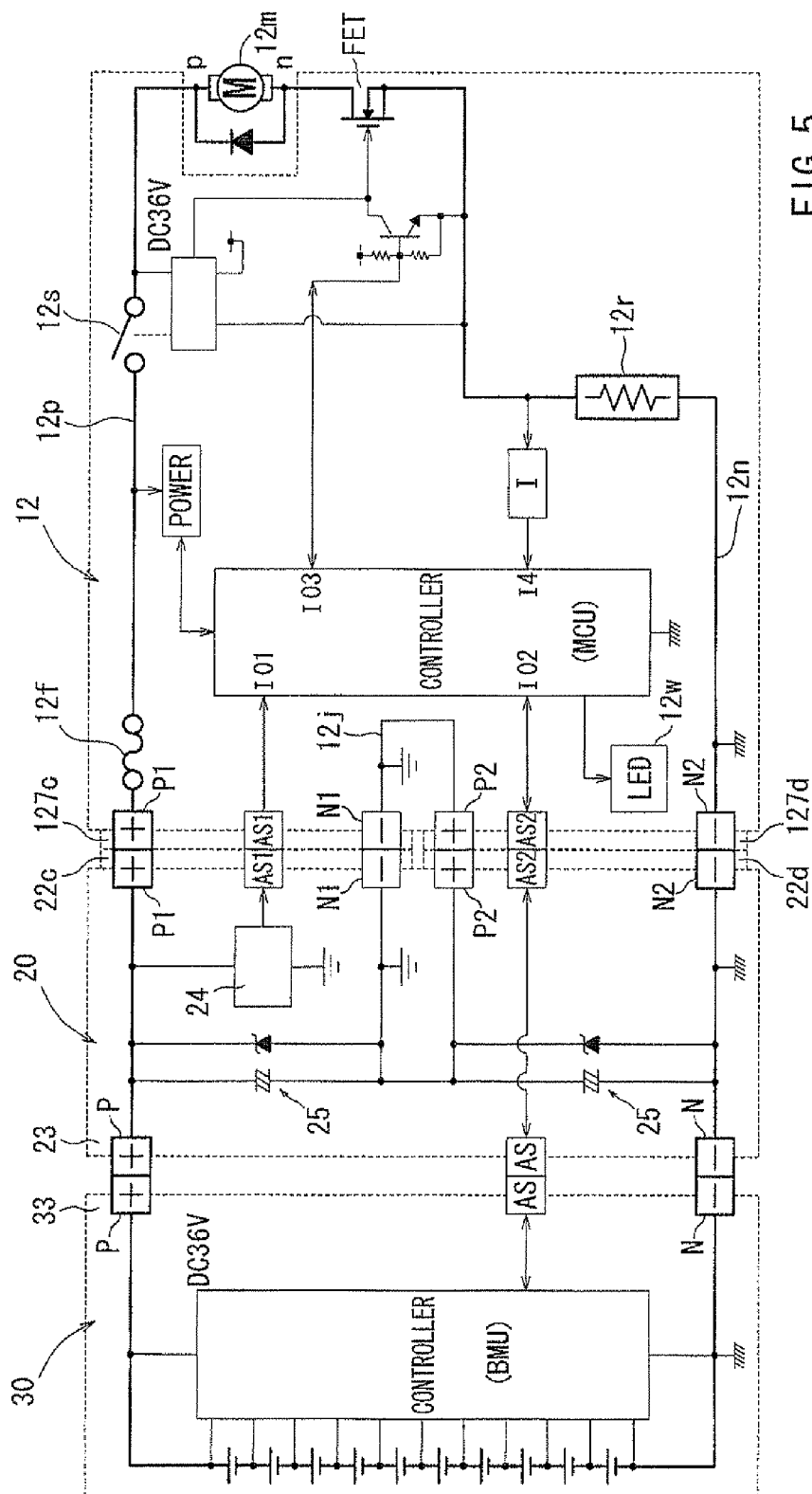


FIG. 4



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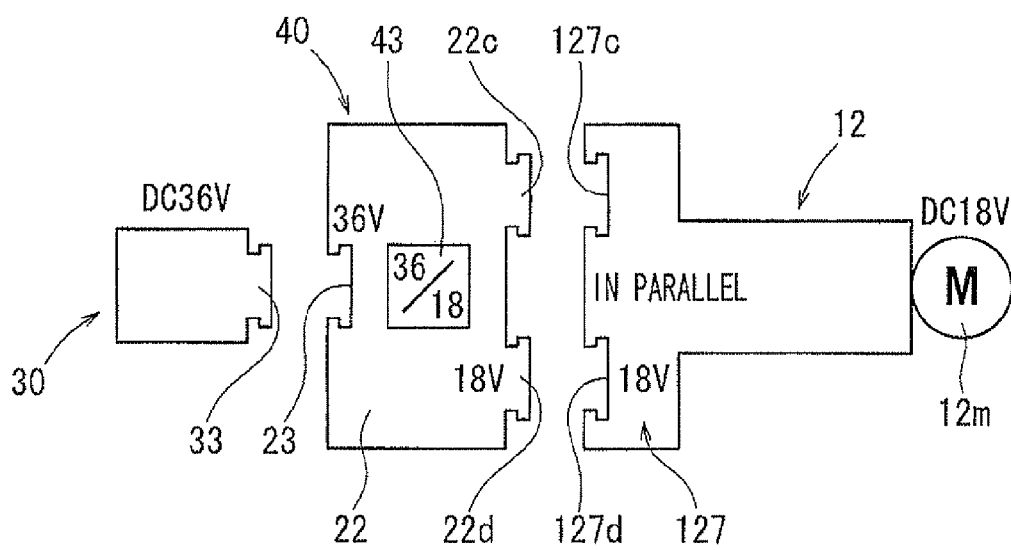


FIG. 6

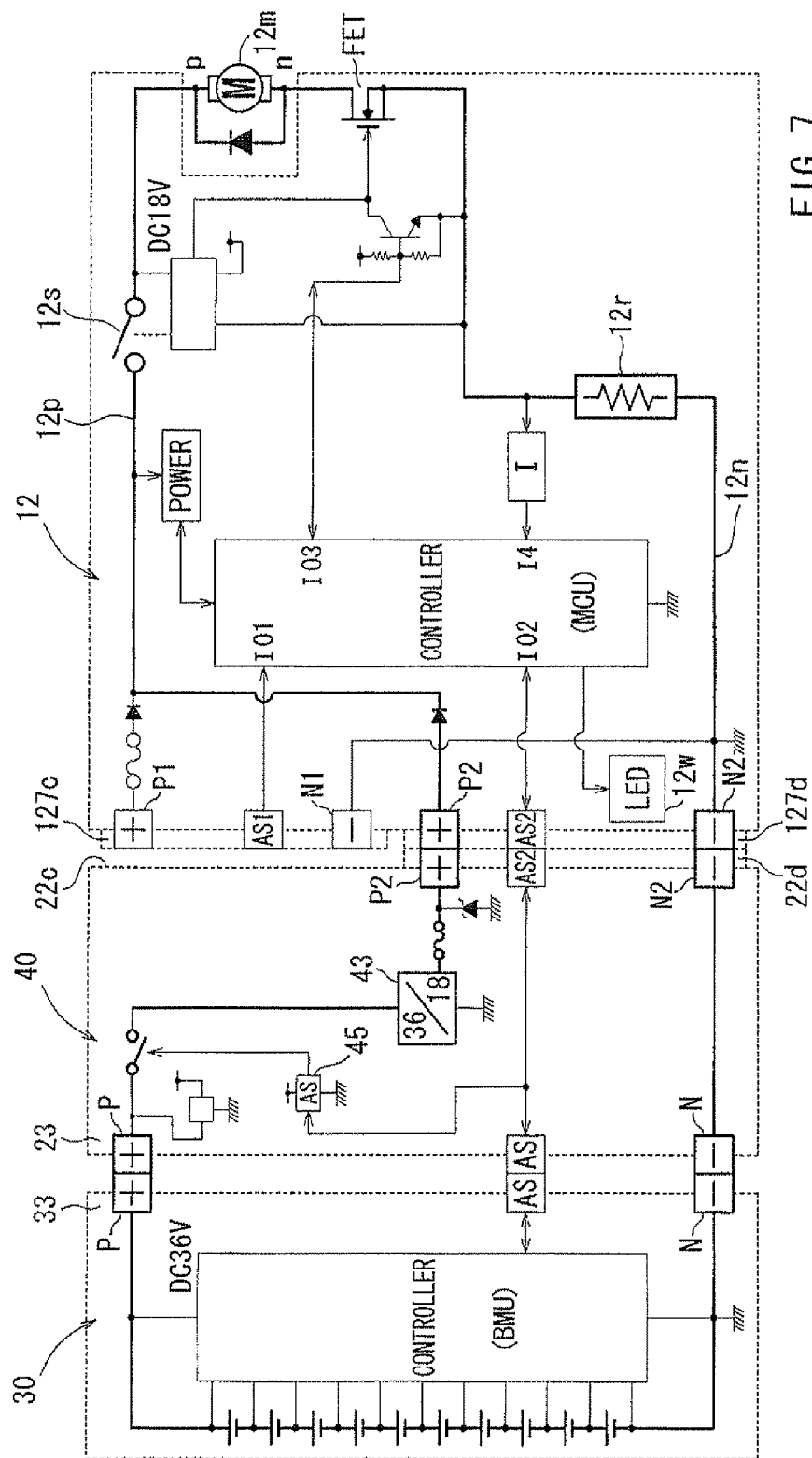
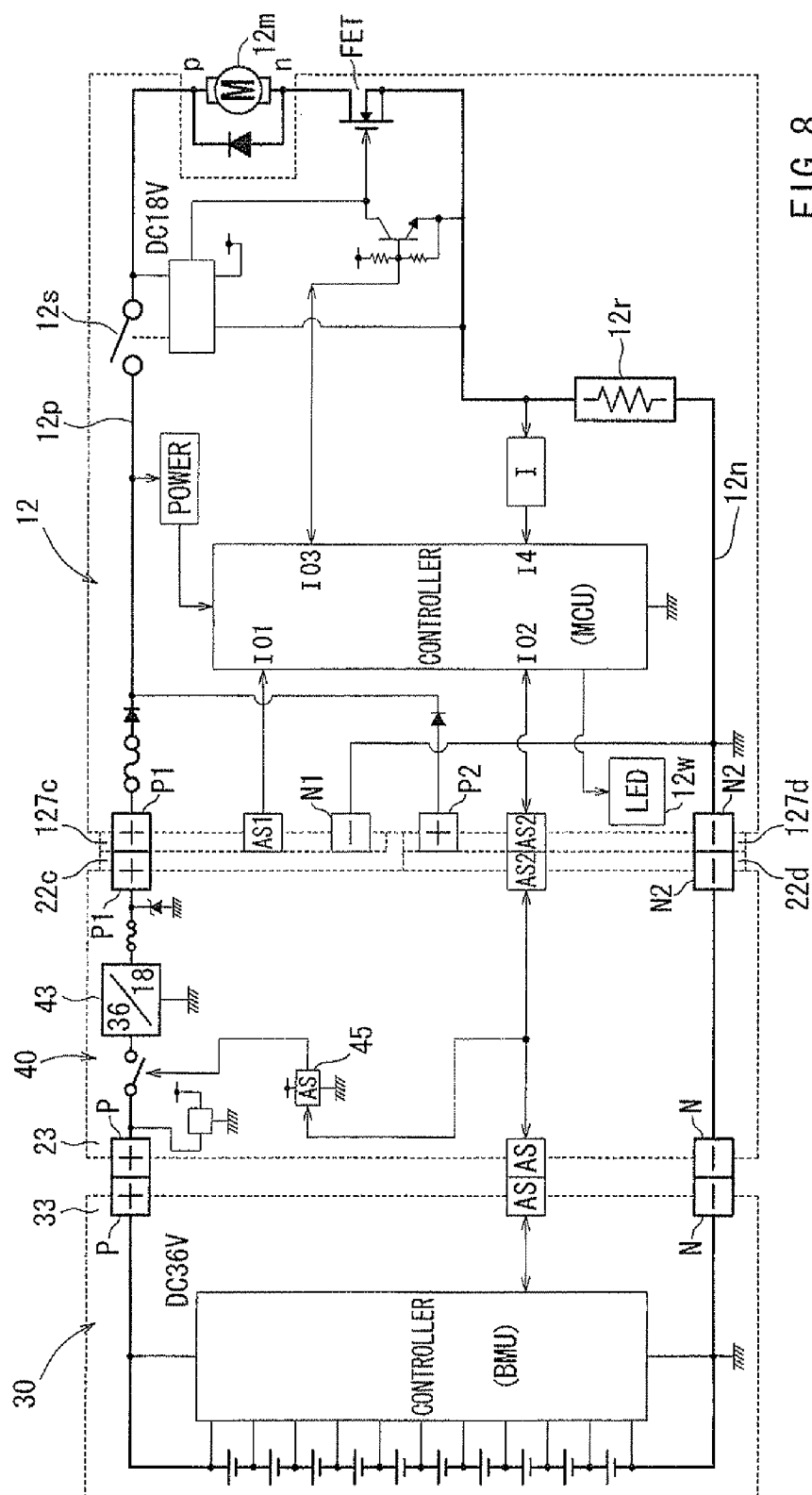


FIG. 7



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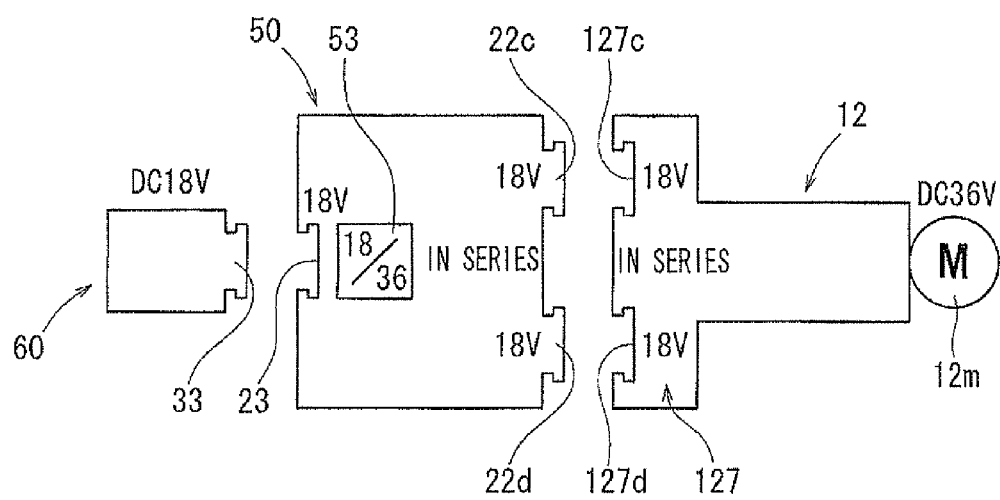
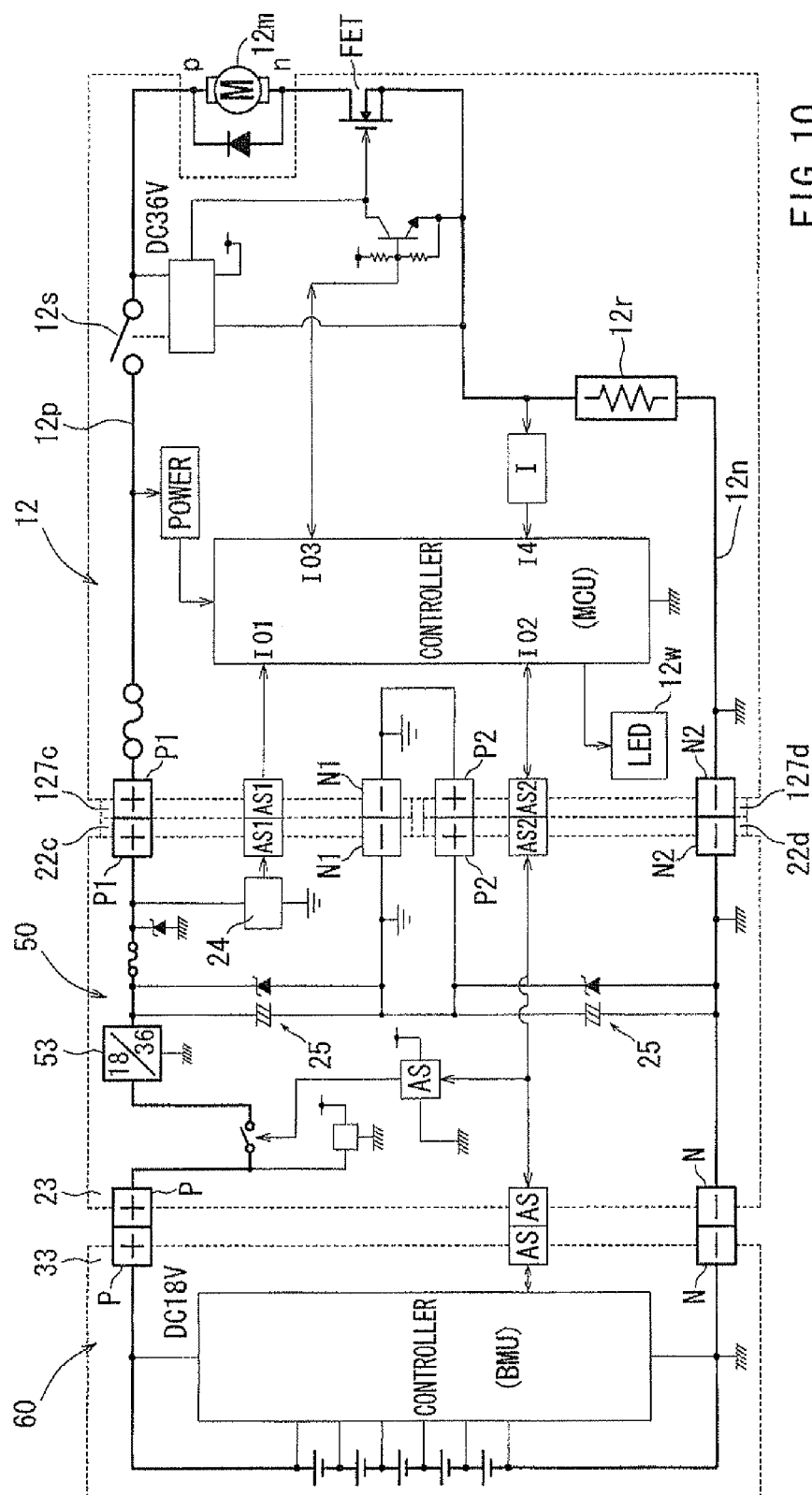


FIG. 9



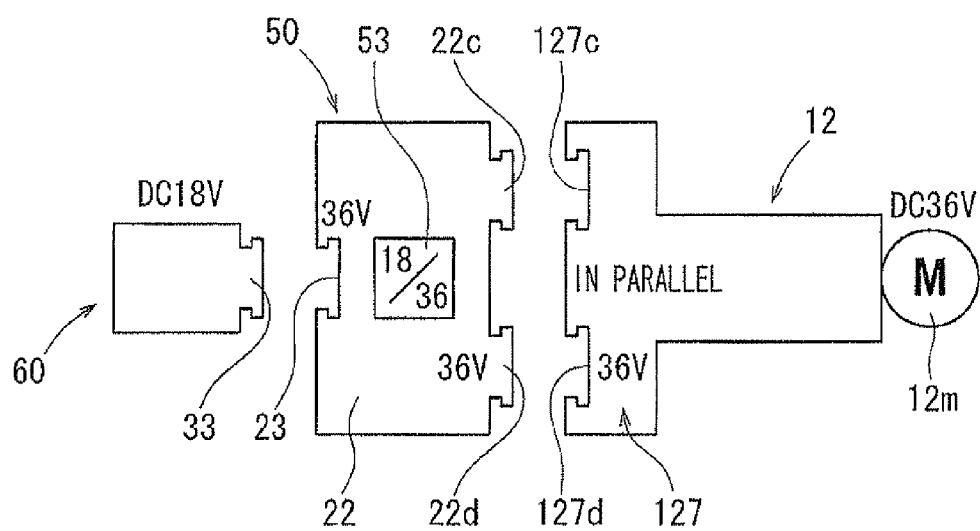
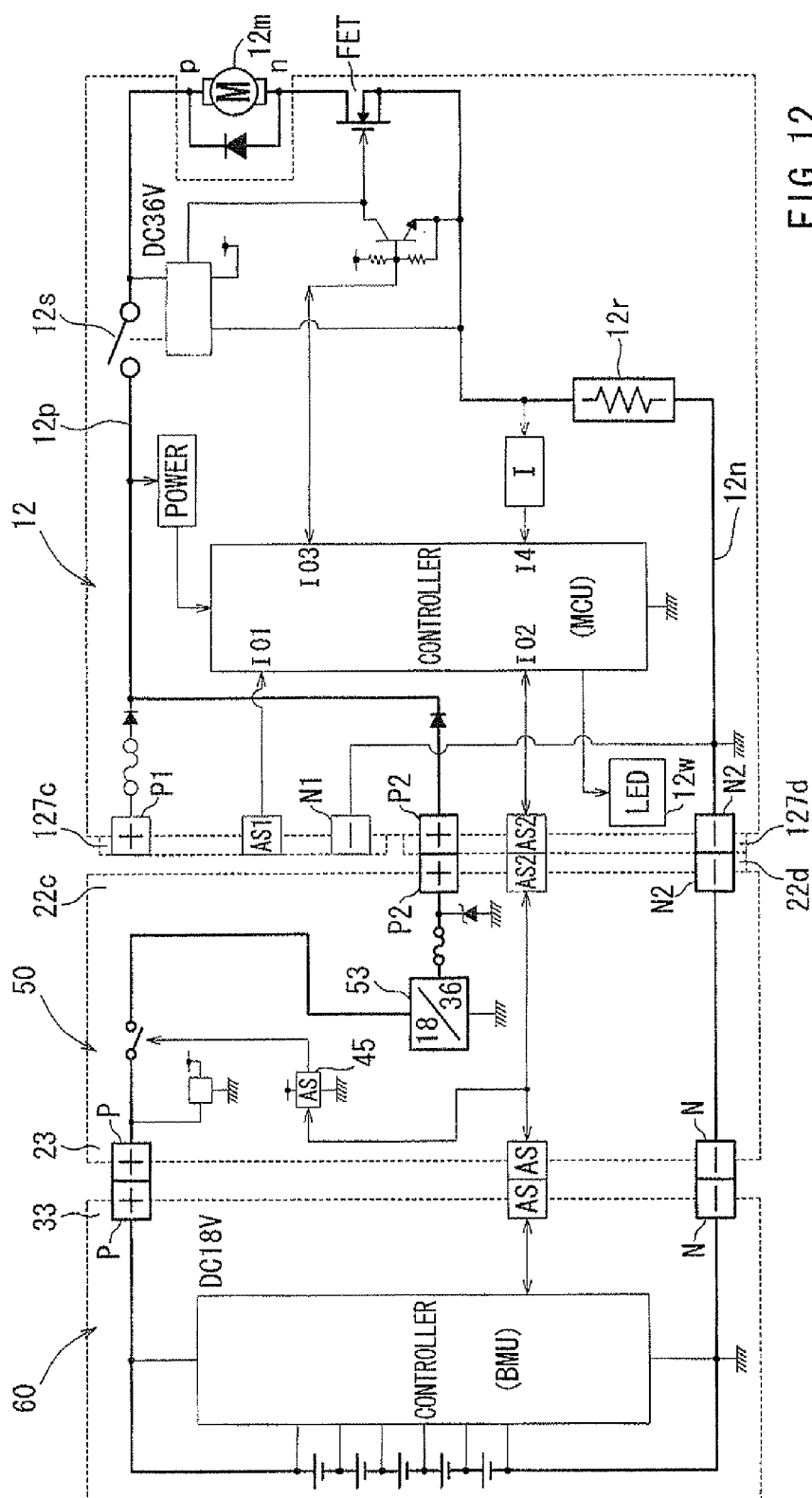


FIG. 11



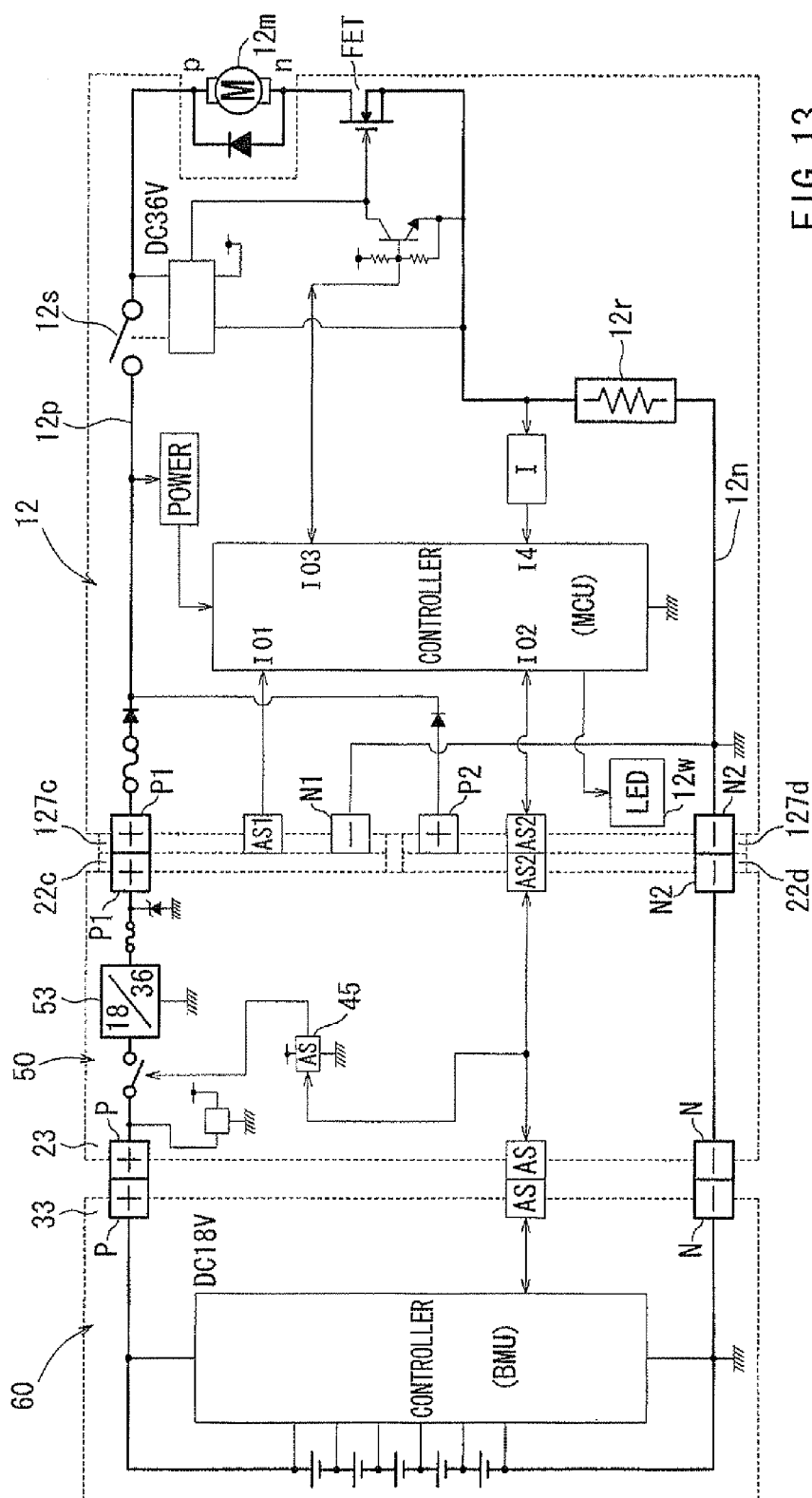


FIG. 13

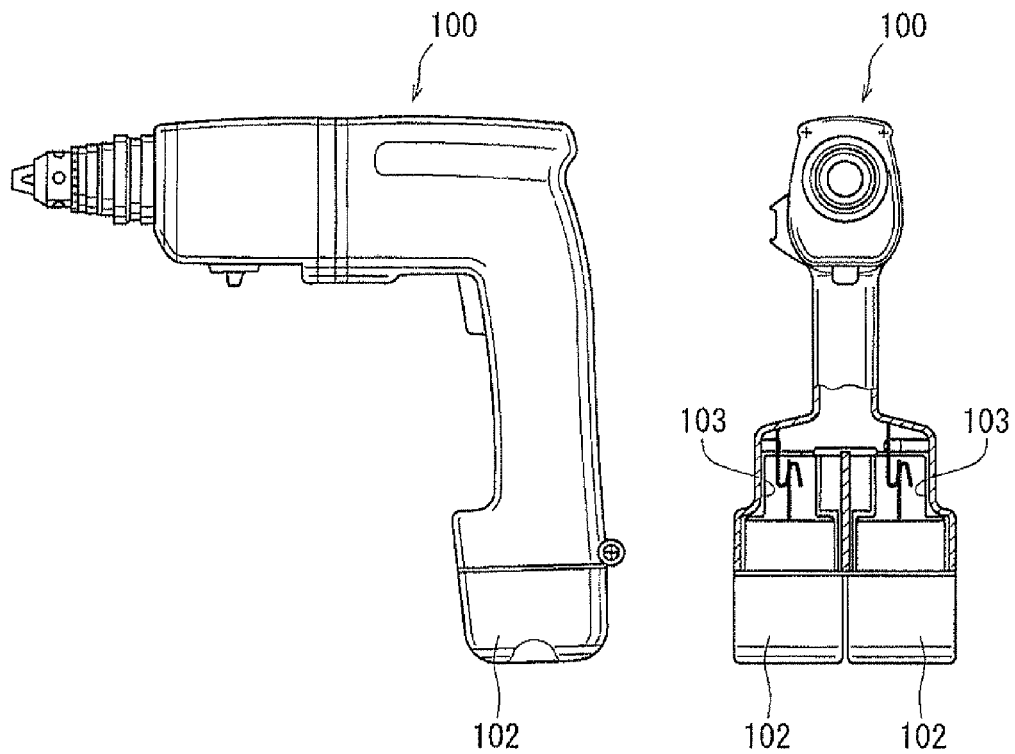


FIG. 14
PRIOR ART

BATTERY ADAPTER

This application claims priority to Japanese patent application serial number 2011-252650, the contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION**1. Field of the Invention**

Certain embodiments of the present invention relate to a battery adapter provided with a plurality of machine-side-connecting sections capable of being connected to a plurality of battery-connecting ports provided in an electric machine, and with a battery-side-connecting section to which a battery can be connected.

2. Description of the Related Art

Generally speaking, in an electric tool or an electric working device (hereinafter termed an electric machine), a battery that corresponds to a rated voltage of a motor of the electric machine is used. For example, in the case of an electric machine with a DC voltage of 36 volts, a battery with a DC voltage of 36 volts is usually used. However, batteries with a DC voltage of 36 volts are rather expensive and are not widely available in the market. In contrast, batteries with a DC voltage of 18 volts are generally used and widely available in the market.

U.S. Pat. No. 5,028,858 discloses an electric tool with a DC voltage of 36 volts that is constructed such that two batteries with a DC voltage of 18 volts can be connected to the electric tool. As shown in FIG. 14, an electric tool 100 as disclosed in the above-mentioned patent document is provided with two battery-connecting ports 103 so that two batteries 102 with a DC voltage of 18 volts can be connected to the ports 103. Further, the electric tool 100 includes an electric circuit for connecting the two batteries 102 in series. Thus, it is possible to drive an electric tool with a DC voltage of 36 volts by generally-used batteries with a DC voltage of 18 volts.

However, in an electric tool with a DC voltage of 36 volts provided with two battery-connecting ports (hereinafter termed as "a two-port electric tool") for batteries with a DC voltage of 18 volts, it is impossible to use a battery with a DC voltage of 36 volts. Nor is it possible to drive a two-port electric tool with a DC voltage of 36 volts by a single battery with a DC voltage of 18 volts.

In this way, a two-port electric tool is not easy to use.

SUMMARY OF THE INVENTION

Thus, there is a need in the art to make it possible for an electric machine provided with a plurality of battery-connecting ports to be operated by a smaller number of batteries than the number of the battery-connecting ports of the electric machine, thereby improving the usability of the electric machine provided with a plurality of battery-connecting ports.

One construction for a battery adapter can include a plurality of machine-side-connecting sections capable of being connected to a plurality of battery-connecting ports provided in an electric machine, and (a) battery-side-connecting section(s) to which a battery or batteries can be connected, where the number of the machine-side-connecting sections is preferably configured to be larger than the number of the battery-side-connecting section(s). Further, the electric machine connected to the machine-side-connecting sections of the battery adapter via the battery-connecting ports of the electric machine can be driven by the battery or batteries connected to the battery-side-connecting section(s) of the battery adapter.

In the battery adapter according to the construction, the number of machine-side-connecting sections is preferably configured to be larger than the number of battery-side-connecting section(s). For example, when the number of machine-side-connecting sections is two, the number of battery-side-connecting section(s) is preferably one. Further, the electric machine connected to the machine-side-connecting sections of the battery adapter via the battery-connecting ports of the electric machine can be driven by the battery or batteries connected to the battery-side-connecting section(s) of the battery adapter.

In this way, by using a battery adapter according to the construction, it is possible to drive, for example, an electric machine provided with two battery-connecting ports by use of a single battery. As a result, it is possible to improve the usability of an electric machine provided with a plurality of battery-connecting ports.

According to another construction, the electric machine connected to the machine-side-connecting sections of the battery adapter via the battery-connecting ports of the electric machine can be driven, with a battery of a nominal voltage that is the same as the rated voltage of a motor of the electric machine being connected to the battery-side-connecting section(s) of the battery adapter.

For this reason, by using the above-described battery adapter, it is possible to drive, for example, a two-port electric machine with a DC voltage of 36 volts by a single battery with a DC voltage of 36 volts.

According to another construction, the sum of the voltages applied to the machine-side-connecting sections of the battery adapter is equal to the rated voltage of the motor of the electric machine.

For this reason, by using the above-described battery adapter, it is possible to drive, for example, a two-port electric machine with a DC voltage of 36 volts provided with two battery-connecting ports for DC 18 volts by a single battery with a DC voltage of 36 volts.

According to another construction, a battery adapter includes a step-down section configured to reduce the battery voltage applied to the battery-side-connecting section(s) to the rated voltage of the motor of the electric machine.

For this reason, by using the above-described battery adapter, it is possible to drive, for example, a two-port electric machine with a DC voltage of 18 volts by a single battery with a DC voltage of 36 volts.

According to another construction, the output voltage of the step-down section is equal to the voltage applied to one of the machine-side-connecting sections.

According to another construction, the output voltage of the step-down section is applied between positive and negative terminals of different sets of the plurality of machine-side-connecting sections.

According to another construction, a battery adapter includes a step-up section configured to increase the battery voltage applied to the battery-side-connecting section(s) to the rated voltage of the motor of the electric machine.

For this reason, by using the battery adapter described above, it is possible to drive, for example, a two-port electric machine with a DC voltage of 36 volts by a single battery with a DC voltage of 18 volts.

According to another construction, the output voltage of the step-up section is configured to be equal to the sum of the voltages applied to the machine-side-connecting sections.

According to another construction, the output voltage of the step-up section is equal to the voltage applied to one of the machine-side-connecting sections.

According to another construction, the output voltage of the step-up section is applied between positive and negative terminals of different sets of the plurality of machine-side-connecting sections.

According to the above, it is possible to operate an electric machine having a plurality of battery-connecting ports by a smaller number of batteries than the number of battery-connecting ports of the electric machine. In this way, the usability of an electric machine provided with a plurality of battery-connecting ports can be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an overall perspective view of a blower (an electric machine) provided with a battery adapter according to an example of the present invention;

FIG. 2 is an exploded perspective view of the electric machine, viewed from above;

FIG. 3 is an exploded perspective view of the electric machine, viewed from below;

FIG. 4 is a diagram showing the configuration of the electric machine;

FIG. 5 is a schematic block diagram showing an electric circuit of the electric machine;

FIG. 6 is a diagram showing the configuration of an electric machine provided with a battery adapter according to another example;

FIG. 7 is a schematic block diagram showing an electric circuit of the electric machine;

FIG. 8 is a schematic block diagram showing an electric circuit of the electric machine;

FIG. 9 is a diagram showing the configuration of an electric machine provided with a battery adapter according to another example;

FIG. 10 is a schematic block diagram showing an electric circuit of the electric machine;

FIG. 11 is a diagram showing the configuration of an electric machine according to another example;

FIG. 12 is a schematic block diagram showing an electric circuit of the electric machine;

FIG. 13 is a schematic block diagram showing the electric circuit of the electric machine; and

FIG. 14 is a side and a front view of a conventional electric tool provided with a pair of seats or sockets for respective battery packs.

Each of the additional features and teachings disclosed above and below may be utilized separately or in conjunction with other features and teachings to provide improved battery adapters. Representative examples of the present teaching, which examples utilize many of these additional features and teachings both separately and in conjunction with one another, will now be described in detail with reference to the attached drawings. This detailed description is merely intended to teach a person of skill in the art further details for practicing preferred aspects of the present teachings and is not intended to limit the scope of the invention. Only the claims define the scope of the claimed invention. Therefore, combinations of features and steps disclosed in the following detailed description may not be necessary to practice the invention in the broadest sense, and are instead taught merely to particularly describe representative examples of the invention. Moreover, various features of the representative examples and the dependent claims may be combined in ways that are not specifically enumerated in order to provide additional useful examples of the present teachings.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following, a battery adapter according to an example will be described with reference to FIG. 1 to FIG. 5. The battery adapter according to the example is for use in electric machines, such as a blower.

The forward, backward, leftward, rightward, upward, and downward directions in the figures correspond to the forward, backward, leftward, rightward, upward, and downward directions in the blower.

The blower 10 is an equipment for blowing away dust, dirt, dust or the like. As shown in FIGS. 1 to 3, the blower 10 includes a blower main body 12, a battery adapter 20, and a battery pack 30 (hereinafter termed the battery 30).

Before describing the battery adapter 20, the configuration of the blower main body 12 will be briefly described.

The blower main body 12 is configured such that air sucked in through a rotating fan (not shown) from an air intake port 121 provided in the central lower surface of the blower main body 12 can be purged through a nozzle 123 at a distal end (front end) of the blower main body 12. At the central part of the blower main body 12, a housing part 124 for housing the fan and a motor 12m, etc. is provided above the air intake port 121. A grip part 125 extends from above the housing part 124 to the rear end position of the blower main body 12. A main switch 12s of the blower main body 12 is provided at an upper position of the grip part 125. Further, at the rear end position of the blower main body 12, a battery connection part 127 is provided.

A battery adapter 20, which is described below, or two DC 18 volts batteries (not shown) may be connected to the battery connection part 127. As shown in FIG. 3, there are provided two sets of battery-connecting ports 127c and 127d on the lower surface side of the battery connection part 127 to which the battery adapter 20 or two DC 18 volts batteries (not shown) can be connected (for example, through a sliding motion).

The blower main body 12 shown in FIGS. 4 and 5 can be driven by the motor 12m rated at 36 VDC. As shown in FIG. 5, one end of a positive power line 12p of the blower main body 12 is connected to a positive terminal P1 of the first battery connection port 127c, and the other end of the positive power line 12p is connected to a positive terminal p of the motor 12m. A fuse 12f and the main switch 12s are connected in series between the two ends of the positive power line 12p. Further, one end of a negative power line 12n of the blower main body 12 is connected to a negative terminal N2 of the second battery connection port 127d, and the other end of the negative power line 12n is connected to a negative terminal n of the motor 12m. Between the two ends of the negative power line 12n, a switching element FET, for adjusting the power supplied to the motor 12m, and a shunt resistor 12r, for detecting a load current of the motor 12m, are connected in series.

Further, as shown in FIG. 5, a negative terminal N1 of the first battery connection port 127c and a positive terminal P2 of the second battery connection port 127d are electrically connected to each other by a jumper line 12j. Therefore, when DC 18 volts batteries (not shown) are respectively connected to the first battery connection port 127c and the second battery connection port 127d, the batteries are connected to each other in series, with the result that a voltage of DC 36 volts is applied to the motor 12m.

Further, a controller MCU (refer to FIG. 5) is mounted in the housing part 124 of the blower main body 12. The controller MCU is configured to operate the switching FET to

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control the motor **12m** (refer to an IO3 terminal). When a discharge signal (discharge enabling signal) is input via AS terminals of the first battery connection port **127c** and the second battery connection port **127d** (refer to IO1 and IO2 terminals), the controller MCU operate to control the motor **12m**. Further, the load current of the motor **12m** is input to the controller MCU (refer to a terminal **14**). When the controller MCU receives an overload current, the MCU stops the motor **12m**, and also outputs an overload signal to the battery via the AS terminal. Further, the controller MCU can output a display signal to a display circuit **12w** of the blower main body **12**.

The battery adapter **20**, which is provided with the first battery connection port **127c** and the second battery connection port **127d**, uses a single battery **30** rated at 36 VDC for driving the blower main body **12** rated at 36 VDC.

As shown in FIGS. 2 and 3, the battery adapter **20** is provided with a thin boxlike housing **22**. On an upper surface of the housing **22**, there is provided a first machine-side-connecting section **22c** and a second machine-side-connecting section **22d** which can be connected through sliding action to the first battery connection port **127c** of the blower main body **12** and the second battery connection port **127d** of the blower main body **12**, respectively. Further, on the lower surface side of the housing **22**, there is provided a battery-side-connecting section **23** to which a connection part **33** of the battery **30** rated at 36 VDC can be connected via slide action.

As shown in FIG. 5, provided on the first machine-side-connecting section **22c** are a positive terminal **P1**, a negative terminal **N1**, and an AS1 terminal to which the positive terminal **P1**, the negative terminal **N1**, and an AS1 terminal of the first battery connection port **127c** of the blower main body **12** are respectively connected. Further, provided on the second machine-side-connecting section **22d** is a positive terminal **P2**, a negative terminal **N2**, and an AS2 terminal to which the positive terminal **P2**, the negative terminal **N2**, and an AS2 terminal of the second battery connection port **127d** of the blower main body **12** are respectively connected.

Further, on the battery-side-connecting section **23** there is provided a positive terminal **P**, a negative terminal **N**, and an AS terminal to which a positive terminal **P**, a negative terminal **N**, and an AS terminal provided on the connection part **33** of the battery **30** are respectively connected. The positive terminal **P** of the battery-side-connecting section **23** is connected to the positive terminal **P1** of the first machine-side-connecting section **22c**, and the negative terminal **N** of the battery-side-connecting section **23** is connected to the negative terminal **N2** of the second machine-side-connecting section **22d**. Further, the AS terminal of the battery-side-connecting section **23** is connected to the AS2 terminal of the second machine-side-connecting section **22d**. Accordingly, a signal from a controller BMU of the battery **30**, such as an over-discharge signal (discharge inhibit signal) etc., is input to the IO2 terminal of the controller MCU of the blower main body **12** via the AS2 terminal of the second machine-side-connecting section **22d** of the battery adapter **20**. Further, an operation signal for the main switch **12s** from the controller MCU of the blower main body **12** is also transmitted to the controller BMU of the battery **30** via the AS2 terminal of the second machine-side-connecting section **22d**.

In the battery adapter **20**, there is provided a discharge output circuit **24** that can output a discharge signal. The output signal is input to the IO1 terminal of the controller MCU of the blower main body **12** via the AS1 terminal of the first machine-side-connecting section **22c**. The controller MCU of the blower main body **12** controls the motor **12m**

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according to an over-discharge signal (discharge inhibit signal) or a discharge signal (discharge enabling signal) input to the IO2 terminal.

Further, in the battery adapter **20**, there is provided a constant-voltage circuit **25** configured such that the same approximate voltage is applied between the positive terminal **P1** and the negative terminal **N1** of the first machine-side-connecting section **22c** and between the positive terminal **P2** and the negative terminal **N2** of the second machine-side-connecting section **22d**.

Next, an operation of the battery adapter **20** will be described.

First, the battery **30** is connected, preferably through slide movement, to the battery-side-connecting section **23** of the battery adapter **20**, and then, the first machine-side-connecting section **22c** and the second machine-side-connecting section **22d** of the battery adapter **20** are connected to the first battery connection port **127c** and the second battery connection port **127d** of the blower main body **12** through sliding motion, as shown in FIG. 1. As a result, as shown in FIG. 5, the positive terminal **P** of the battery **30** is connected to the positive terminal **P1** of the first battery connection port **127c** of the blower main body **12** via the positive terminal **P1** of the first machine-side-connecting section **22c** of the battery adapter **20**. Further, the negative terminal **N** of the battery **30** is connected to the negative terminal **N2** of the second battery connection port **127d** of the blower main body **12** via the negative terminal **N2** of the second machine-side-connecting section **22d** of the battery adapter **20**. Further, the AS terminal of the battery **30** is connected to the AS2 terminal of the second battery connection port **127d** of the blower main body **12** via the AS2 terminal of the second machine-side-connecting section **22d** of the battery adapter **20**.

As a result, DC 18 volts is applied between the positive terminal **P1** and the negative terminal **N1** of the first battery connection port **127c** and between the positive terminal **P2** and the negative terminal **N2** of the second battery connection port **127d** of the blower main body **12**. That is, the voltage of the first battery connection port **127c** (DC 18 volts) and the voltage of the second battery connection port **127d** (DC 18 volts) are applied in series to the motor **12m** of the blower main body **12**. As a result, it is possible to drive the blower main body **12** rated at 36 VDC, which is provided with the first battery connection port **127c** and the second battery connection port **127d**, by use of a single battery **30** rated at 36 VDC.

In the battery adapter **20** according to the example, it is possible to drive the blower main body **12** (electric machine) provided with a plurality of (two) battery-connecting ports **127c** and **127d** by use of a single battery **30**. This can improve the usability of the blower main body **12** provided with a plurality of (two) battery-connecting ports **127c** and **127d**.

Further, the sum of the voltages applied to the machine-side-connecting sections **22c** and **22d** (DC 18 volts) of the battery adapter **20** is equal to the rated voltage (DC 36 volts) of the motor **12m** of the blower main body **12** (electric machine). For this reason, the above-described battery adapter **20** makes it possible to drive a two-port blower main body **12** (electric machine) rated at 36 VDC, which is provided with two battery-connecting ports **127c** and **127d** for batteries rated at 18 VDC, by use of a single battery rated at 36 VDC.

In the following, a battery adapter **40** according to another example will be described with reference to FIGS. 6 to 8.

As shown in FIG. 6, the battery adapter **40** according to the example can drive an electric machine **12** rated at 18 VDC provided with a first battery connection port **127c** and a sec-

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ond battery connection port **127d** by use of a single battery **30** rated at 36 VDC. The basic configuration of the battery adapter **40** according to the example is the same as that of the battery adapter **20** according to the first example. Therefore, the members that are the same as those of the battery adapter **20** according to the first example are indicated by the same reference numerals, and an explanation of the battery adapter **40** will be left out.

As shown in FIG. 7, the electric machine **12** of this example is configured such that a battery rated at 18 VDC (not shown) can be connected in parallel to the first battery connection port **127c** and the second battery connection port **127d**. That is, in the above electric machine **12**, the parallel connection is made between the positive terminal **P1** and the negative terminal **N1** of the first battery connection port **127c** and between the positive terminal **P2** and the negative terminal **N2** of the second battery connection port **127d**. As a result, the approximately same voltage that is applied to the first battery connection port **127c** and the second battery connection port **127d** (DC 18 volts) will be applied to the motor **12m**.

As is the case with the first example, the battery adapter **40** is provided with a first machine-side-connecting section **22c** and a second machine-side-connecting section **22d**. However, as shown in FIG. 7, the first machine-side-connecting section **22c** of the battery adapter **40** does not include positive and negative terminals, and solely allows a mechanical connection with the first battery connection port **127c** of the electric machine **12**. That is, only the second machine-side-connecting section **22d** of the battery adapter **40** can be electrically connected to the second battery connection port **127d** of the electric machine **12**.

The battery adapter **40** is provided with a step-down section **43** configured to reduce the voltage (DC 36 volts) applied to the positive terminal **P** and the negative terminal **N** of the battery-side-connecting section **23**. The step-down section **43** is configured to reduce DC 36 volts to DC 18 volts. The output voltage (DC 18 volts) of the step-down section is applied between the positive terminal **P2** and the negative terminal **N2** of the second machine-side-connecting section **22d**. As a result, a voltage of DC 18 volts is applied to the second battery connection port **127d** of the electric machine **12**.

Further, the battery adapter **40** is provided with an AS output circuit **45**. The AS output circuit is configured to shut off the input power of the step-down section **43** upon receiving an operation signal for the main switch **12s** of the controller MCU of the electric machine **12**, or an over-discharge signal, etc., from the controller BMU of the battery **30**.

Therefore, the above-described battery adapter **40** makes it possible to drive the electric machine **12** provided with the first battery connection port **127c** and the second battery connection port **127d** by use of a single battery **30** rated at 36 VDC. In this way, it is possible to use the battery **30** rated at 36 VDC in order to drive the electric machine **12** rated at 1 VDC, and thus the electric machine may be advantageously operated for a longer period of time.

The above construction may not be limited by the above-described example and various changes may be made without departing from the scope of the invention. In FIG. 7, only the second machine-side-connecting section **22d** is used, without electrically using the first machine-side-connecting section **22c** of the battery adapter **40**. However, as shown in FIG. 8, it is possible to apply DC 18 volts between the positive terminal **P1** of the first machine-side-connecting section **22c** and the negative terminal **N2** of the second machine-side-connecting section **22d**, for example. That is, it is possible to apply a voltage of DC 18 volts to the motor **12m** via the positive terminal **P1** of the first battery connection port **127c** and the

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negative terminal **N2** of the second battery connection port **127d** of the electric machine **12**.

In the following, a battery adapter **50** according to another example will be described with reference to FIGS. 9 to 13.

As shown in FIG. 9, the battery adapter **50** according to the example can drive the electric machine **12** rated at 36 VDC provided with the first battery connection port **127c** and the second battery connection port **127d** by use of a single battery **60** rated at 18 VDC. The basic configuration of the battery adapter **50** according to the example is the same as that of the battery adapter **20** according to the first example. Therefore, the members that are the same as those of the battery adapter **20** according to the first example are indicated by the same reference numerals, and a description of the battery **50** will be left out.

Further, the electric machine **12** in the example is the same as the electric machine **12** in the first example. Therefore, the members of the electric machine **12** are indicated by the same reference numerals, and a description of the electric machine **12** will be left out.

As shown in FIG. 10, the battery adapter **50** is provided with a step-up section **53** configured to increase the voltage (DC 18 volts) applied to the positive terminal **P** and the negative terminal **N** of the battery-side-connecting section **23**. The step-up section **53** is configured to increase DC 18 volts to DC 36 volts. The output voltage (DC 36 volts) of the step-up section is applied between the positive terminal **P1** of the first machine-side-connecting section **22c** and the negative terminal **N2** of the second machine-side-connecting section **22d**. Further, on the output side of the step-up section **53**, there is provided a constant-voltage circuit **25** configured such that the same voltage (DC 18 volts) is applied between the positive terminal **P1** and the negative terminal **N1** of the first machine-side-connecting section **22c** and between the positive terminal **P2** and the negative terminal **N2** of the second machine-side-connecting section **22d**.

As a result, a voltage of DC 18 volts is applied to the first battery connection port **127c** and the second battery connection port **127d** of the electric machine **12** via the first machine-side-connecting section **22c** and the second machine-side-connecting section **22d**, respectively, of the battery adapter **50**. That is, a voltage of DC 36 volts is applied to the motor **12m** of the electric machine **12**. The voltage of the first battery connection port **127c** (DC 18 volts) and the voltage of the second battery connection port **127d** (DC 18 volts) are connected in series.

Accordingly, it is possible to drive the electric machine **12** rated at 3 VDC, which is provided with a first battery connection port **127c** and a second battery connection port **127d**, by use of a single battery **60** rated at 18 VDC.

The above construction may not be limited by the above-described example and various changes may be made without departing from the scope of the invention. In FIG. 10, a voltage of DC 36 volts is applied to the motor **12m** by connecting the first battery connection port **127c** and the second battery connection port **127d** of the electric machine **12** in series.

However, as shown in FIGS. 11 and 12, it is possible to apply a voltage of DC 36 volts between the terminals **P2** and **N2** of the second machine-side-connecting section **22d** of the battery adapter **50**, without mounting the constant-voltage circuit **25**. As a result, it is possible to use the battery adapter **50** for the electric machine **12** in which a battery rated at 36 VDC is connected to the first battery connection port **127c** and the second battery connection port **127d** in parallel, as shown in FIG. 12.

Further, as shown in FIG. 13, it is also possible to apply a voltage of DC 36 volts between the positive terminal P1 of the first machine-side-connecting section 22c and the negative terminal N2 of the second machine-side-connecting section 22d of the battery adapter 50, without mounting the constant-voltage circuit 25. As a result, it is possible to use the battery adapter 50 for the electric machine 12 in which a battery rated at 36 VDC is connected to each of the first battery connection port 127c and the second battery connection port 127d in parallel, as shown in FIG. 13.

In the first example to the third example, the battery adapter 20, 40, and 50 is provided with two machine-side-connecting sections 22c and 22d and one battery-side-connecting section 23. However, it is also possible to change the number of machine-side-connecting sections and the number of battery-side-connecting sections as appropriate but preferably such that the number of machine-side-connecting sections is larger than the number of battery-side-connecting sections.

Further, in the first through the third examples, the blower 10 is shown as an example of the electric machine 12. However, a chain saw, a hedge trimmer, and other electric tools such as those for a drill or an electric screwdriver that use an external battery or batteries can also be used with the invention.

We claim:

1. A battery adapter, comprising a plurality of machine-side-connecting sections that can be connected to a plurality of battery-connecting ports provided on an electric machine and also comprising a battery-side-connecting section that can be connected to a battery such that the electric machine is drivable by the battery when the electric machine is connected to the machine-side-connecting sections of the battery adapter via the battery-connecting ports of the electric machine and the battery is connected to the battery-side-connecting section of the battery adapter, wherein;

each of the machine-side-connecting sections comprises a positive terminal and a negative terminal and the battery-side-connecting section comprises a positive terminal and a negative terminal.

2. The battery adapter according to claim 1, wherein there are a plurality of battery-side-connecting sections and further that the number of the machine-side-connecting sections is configured to be larger than the number of the battery-side-connecting sections and further wherein each of the plurality of battery-side-connecting sections comprises a positive terminal and a negative terminal.

3. The battery adapter according to claim 1, wherein the electric machine connected to the machine-side-connecting sections of the battery adapter via the battery-connecting ports of the electric machine can be driven by a battery the nominal voltage of which is substantially equal to the rated voltage of a motor of the electric machine, the battery being connected to the battery-side-connecting section of the battery adapter.

4. The battery adapter according to claim 3, wherein the sum of the voltages applied to the machine-side-connecting sections of the battery adapter is equal to the rated voltage of the motor of the electric machine.

5. The battery adapter according to claim 1, wherein the battery adapter includes a step-down section that is configured to reduce the battery voltage applied to the battery-side-connecting section; and

the output voltage of the step-down section is configured to be equal to the rated voltage of the motor of the electric machine.

6. The battery adapter according to claim 2, wherein the battery adapter includes a step-down section that is configured to reduce the battery voltage applied to the battery-side-connecting sections; and

the output voltage of the step-down section is configured to be equal to the rated voltage of the motor of the electric machine.

7. The battery adapter according to claim 5, wherein the output voltage of the step-down section is equal to the voltage applied to one of the machine-side-connecting sections.

8. The battery adapter according to claim 5, wherein the output voltage of the step-down section is applied between positive and negative terminals of different sets of the plurality of machine-side-connecting sections.

9. The battery adapter according to claim 1, wherein the battery includes a step-up section configured to increase the battery voltage applied to the battery-side-connecting section; and

the output voltage of the step-up section is configured to be equal to the rated voltage of the motor of the electric machine.

10. The battery adapter according to claim 2, wherein the battery includes a step-up section configured to increase the battery voltage applied to the battery-side-connecting sections; and

the output voltage of the step-up section is configured to be equal to the rated voltage of the motor of the electric machine.

11. The battery adapter according to claim 9, wherein the output voltage of the step-up section is configured to be equal to the sum of the voltages applied to the machine-side-connecting sections.

12. The battery adapter according to claim 9, wherein the output voltage of the step-up section is equal to the voltage applied to one of the machine-side-connecting sections.

13. The battery adapter according to claim 9, wherein the output voltage of the step-up section is applied between positive and negative terminals of different sets of the plurality of machine-side-connecting sections.

14. A battery adapter for use with an electric machine, comprising:

a battery-side-connection section configured to receive a battery voltage from one or more batteries; and

a plurality of machine-side-connecting sections configured to transmit an output voltage from the battery adapter to the electric machine,

wherein the number of machine-side-connections is greater than the number of battery-side-connections; and

wherein the battery adapter has a step-up and step-down function configured to adjust the battery voltage such that the output voltage from the machine-side-connecting sections is sufficient to power the electric machine.

15. A battery adapter comprising a plurality of machine-side-connecting sections configured to be connected to a plurality of battery-connecting ports provided on an electric machine and also comprising a battery-side-connecting section configured to be connected to a battery such that the electric machine is drivable by the battery when the electric machine is connected to the machine-side-connecting sections of the battery adapter via the battery-connecting ports of the electric machine and the battery is connected to the battery-side-connecting section of the battery adapter, wherein: the number of machine-side-connections is greater than the number of battery-side-connections;

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a battery-side-signal terminal that is connected to a signal terminal of the battery is provided in the battery-side-connecting section;

a machine-side-signal terminal that is connected to a signal terminal of the battery-connecting port on the electric machine is provided in the machine-side-connecting section;

a signal is transmitted between the signal terminal of the battery and the signal terminal of the battery-connecting port on the electric machine via the battery-side-signal terminal and the machine-side-signal terminal of the battery adapter; and

the number of machine-side-signal terminals is greater than the number of battery-side-signal terminals.

16. The battery adapter according to claim **15**, wherein:

a plurality of machine-side-signal terminals are provided in the battery-side-connecting sections; and

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at least one of the machine-side-signal terminals transmits a discharge enable signal that permits discharge of the battery.

17. The battery adapter according to claim **16**, wherein the discharge enable signal is transmitted when the battery is connected to the battery-side-connecting section.

18. The battery adapter according to claim **17**, wherein a machine-side-signal terminal other than the machine-side-signal terminal that transmits the discharge enable signal transmits a discharge enable signal that permits discharge of the battery or a discharge inhibit signal that inhibits discharge of the battery.

19. The battery adapter according to claim **15**, wherein a discharge enable signal that permits discharge of the battery or an overload signal of the electric machine is transmitted between the battery and the electric machine via the battery-side-signal terminal and the machine-side-signal terminal of the battery adapter.

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